"LEAD FREE MONOBLOC EXPANSION PROJECTILE AND MANUFACTURING PROCESS".

BACKGROUND OF THE INVENTION

It is recognized today that the use of lead or other toxic material in a bullet constitutes a great nuisance for the environment *and the user*, and must therefore be avoided.

It is also well know that projectiles, particularly those used in police operations or personal defense, must feature a high capability for stopping an attacker at once, without traversing the target and thus perhaps wounding other people. That is particularly important when the use of said ammunition is considered under extreme situations, such as those involving life risk for the police officer, an innocent pedestrian, etc.

These projectiles, used in police operations, must be able to pass through tactical obstacles that offer protection to the criminal such as vehicle doors or windscreen. However, the projectile must be able to do it without changing it's trajectory, lest there is serious risk of injuring innocent people which are not being targeted by police action.

DESCRIPTION OF RELATED ART

Projectiles deforming on impact have been known for a long time, and were initially made of lead, usually with a hollow point. Nowadays these projectiles are made of solid materials, and are generally composed of two pieces, with the fore piece generally made of plastic, or sometimes metal acting as a pusher to create expansion. Examples of said projectiles in the state of the art can be found on "REDUCED-CONTAMINANT DEFORMABLE BULLET, PREFERABLY FOR SMALL ARMS" by Knappworst et al. (WO 01/67030 A1); "SMALL-CALIBRE DEFORMATION PROJECTILE AND A METHOD FOR THE PRODUCTION OF THE SAME" - Baumgartner et al. (WO 01/88460 A1); "DEFORMATION PROJECTILE " - Sigl et al. (WO 01/02791 A1); "Projectile Pour Armes à Feu Notamment Pour Armes de Poing et armes à canon long" - A Dynamit Nobel (FR 2369538); "Jacketless hunting bullet with roll-back cutting flags" - A Avcin (US 4 044 685); "Cartridge for hand and shoulder firearms" - Schirnecker (US 4136616 A); "DEFORMATION PROJECTILE" - DNAG (WO 01/02791 A2); "PROJECTILE" - Winter (US 5160805), "Projectile with improved flowering" - Petrovich et al.(US 5 185 495)).

Another type of solid monobloc projectile operation is based on the internal geometry of the bullet cavity, which features a shape resembling a star, or another specific geometry which performs the same way. These can be found on "Methods of manufacturing a bullet" - Brooks (US 5 131 123) and "Intermediate article used to form a bullet projectile or component and a finally formed bullet" - Brooks (US 5 259 320).

Another type of solid monobloc projectile is a single piece solid, without cuts or cavities, generally for big game hunting, featuring maximum penetration. Examples of these are found on "Solid projectiles" - Lufty (US 4 811 666) and "Projectile" - Hatcher (US 2 234 165). These projectiles feature very little expansion.

Yet another type of solid monobloc projectile operates by means of an internal cavity with a central pin or axis, being the external portion of the bullet provided with grooves to generate the targeted expansion. An example would be "EXPANSION PROJECTILE" - Winter (WO 97/40334).

The Inventor chooses to make no comments here on the classic hollow point projectiles composed of a core and a jacket, which lie outside the scope of the present invention.

SUMMARY OF THE INVENTION

The present invention can be better understood by analyzing the specification text along with the attached set of Figures, in which:

Figure 1a shows a typical example of a projectile described in the present invention, which general external shape include a main cylindrical portion, a front portion of generally ogival shape and a rounded bottom portion, the same Figure 1a is used to illustrate the projectile's longitudinal section, with an internal cavity of substantially elliptical shape. In this example, the largest cross-sectional diameter is situated between the front open portion of the projectile and the bottom of the internal cavity, being said bottom a flat surface. This same Figure 1a is used to illustrate one of a plurality of external deformations with the form of grooves that extend externally from the front end of

the projectile. The purpose of said plurality of grooves is to facilitate the expansion or mushrooming of the projectile.

Figure 1b shows a typical shape of an alternative projectile, with a front portion of truncated conical shape, and a cavity with a generally rounded bottom shape, being the remainder portions of this projectile identical to their analogs of Figure 1a. It is always worth to remember that both Figure 1a and Figure 1b are given solely as non-limitative examples.

Figure 2a is a front view illustrating a typical projectile with axially symmetrical shaped cavity (hexagonal shape in this example).

Figure 2b a front view illustrating a typical projectile with axially symmetrical shaped cavity (hexagonal shape in this example).

Figure 3 shows a typical intermediate shape of a metal piece illustrating its appearance after the first cold forming operations of the manufacturing sequence with a typical example of cavity with a cylindrical portion, a generally conical/elliptical portion and a generally flat bottom portion.

Figure 4 illustrates parts of a typical manufacturing sequence, showing successively:

Copper or copper alloy cylinder after cutting a wire or rod; copper or copper alloy piece after first cold deformations; initial projectile ogive or conical fore portion forming and external grooves forming; final fore portion forming; the calibration, annealing, and surface finishing do not change the general form of the bullet.

It is worth observing that all shapes and geometries described herein refer to both the internal and external geometries.

One of the objects of the present invention is to disclose a projectile that easily and quickly deforms upon expansion after penetrating soft targets, generating an expansion of at least 40% compared to the puncture diameter measured on the initial impact surface, with no loss of original weight, no breakage of the projectile, performing a fast transfer of energy in the early

portion of the trajectory inside the soft environment, and avoiding unintentional hits on secondary targets.

Another object of the present invention is a projectile that easily perforates hard targets without breaking or changing its trajectory.

Another object of the present invention is a projectile that contains no lead or other hazardous material.

Another object of the present invention is a projectile which homogenous construction allows high performance in the aspect of accuracy.

Yet another object of the present invention is a projectile easy to manufacture at a reasonable cost, with existing manufacturing tools and technology.

The present invention applies to any handgun, rifle or shotgun ammunition; when used in smoothbores, the essential stability of the bullet is achieved by positioning the center of gravity ahead of the aerodynamic center.

The present invention attains the objects described above through the combination of characteristics which are discussed in the following paragraphs.

Material:

The present invention discloses a solid projectile (made of one single piece) of a material which density preferably ranges from 6 to 10. Said material is preferably copper or a copper alloy, with a Vickers hardness preferably ranging from 40 to 70.

Internal Cavity:

The projectile features an internal cavity centered regarding the longitudinal axis of construction. The longitudinal section of said cavity preferably presents a generally elliptical shape, with or without a cylindrical portion interspersed. In order to describe the shape of said internal cavity, the Inventor chose to use a radial coordinate system, in which (r) is the radius of a circumference which is normal to the longitudinal axis of the projectile and (d) is the abscise of a generic point which lies in said longitudinal axis of the projectile. The various values assumed by (d, r) describe successive circumferences (all of them normal to the longitudinal axis of the projectile) which make up the perimeter

of the internal cavity. The origin adopted for said coordinates system is the point of the longitudinal axis of the projectile which lies in the same plan that contains the forward most section of the projectile (i.e. the front end of the projectile, where d=0).

For instance, the maximum value of (d) corresponds to the bottom of the internal cavity.

The ideal proportions for the internal cavity of the projectile of the present invention are defined regarding the caliber of said projectile, being the caliber defined by the diameter of the cylindrical portion of the projectile:

- the maximum value of r is situated between the positions where the value of d = 0 and d = $d_{maximum}$;
- said radius r decreases progressively towards the front end where d = 0;
- said radius r decreases progressively towards the bottom of the cavity where d = $d_{maximum}$;
- where d = 0 (front end of the projectile) said radius r ranges from 10 % to 40% of the caliber of said projectile;
- the maximum value of said radius r of said internal cavity ranges from 10% to 40% of the caliber of the projectile;
- where d = $d_{maximum}$ (bottom of the cavity) said radius r ranges from 0 (flat surface) to 35% of the caliber of said projectile (rounded bottom);
- $d_{maximum}$ ranges from 0.50 to 2.5 times the caliber of said projectile;
- the transversal and longitudinal cross-sections of said cavity present radial symmetry regarding the longitudinal axis of said projectile, being said cavity cross-section of a circular or other regular geometrical figure shape.

External Grooves:

The projectile of the present invention features a plurality of grooves, slits or other geometrical forms that extent longitudinally over the external face of the projectile. The purpose of said plurality of grooves is to facilitate the opening of the projectile and avoid breaking. The number of grooves or slits preferably ranges from 3 to 9. The cross section of said grooves is

preferably of a generally triangular shape, and their length is preferably superior to 5 % of the length of the internal cavity.

Said grooves or slits extend from near the front end of the projectile to a maximum length where the cross-section where is located the crimping or the case mouth. Let us remember that the bullet is mounted to a case containing propulsive powder and primer, being said case crimped to the bullet in order to hold it in place, and said crimping forming a generatrice on the cylindrical portion of the bullet.

Bottom Portion of the Cavity:

The bottom portion of the central cavity is either a three-dimensional rounded end or a plan surface with circular perimeter, that being described by the values of (r, d) for the region of the bottom of the cavity.

These characteristics of solid monobloc construction, suitable material and hardness (copper or copper alloy and final annealing to obtain a Vickers hardness of 40 to 70), geometry of the internal cavity and the external grooves are responsible for the outstanding performance of the present invention. The bullet will nor break, even upon hitting hard targets such as a safety glass or multiple sheets of steel; the bullet will rapidly mushroom or expand and thus is able to generate a rapid transfer of energy into soft targets.

MANUFACTURING SEQUENCE

The bullet of the present invention can be constructed following this general manufacture sequence:

a) Cutting of a proper cylinder blank, preferably by cutting, sawing or shearing a wire or rod of suitable material, such as copper or copper alloy.

b) Cold forming of a preliminary internal cavity centered on the longitudinal axis of said cylinder blank, were the geometry of said cavity is roughly equal to that of a cylinder in which the radius varies a little along certain portions of its length. Said preliminary internal cavity may or may not include a portion of pure cylindrical shape (r = constant), and the bottom of said cylinder may correspond to a section of a sphere (r progressively diminishing towards the bottom of the cavity) or a

sheer plan surface (r abruptly made = 0). The shaping of the preliminary internal cavity is controlled by simply varying the values of (r, d) of the punch used in the cold forming according to the desired shape of the cavity. Said cold forming involves one or more strikes of suitable punches on the chosen end of the cylinder blank obtained on the previous cutting step creating a deformation axially symmetrical to the longitudinal axis of said cylinder blank, said obtained final deformation forming a preliminary internal cavity presenting a larger radius r toward the front end of the projectile where d = 0 is zero, with the radius r of said internal cavity varying preferably as:

- the maximum value of radius r of said internal cavity is situated where d = 0, ranging preferably from 95 % to 70% of the radius of said cylinder blank;
- With a cylindrical portion, situated between the front end and the bottom of the cavity, the length of said cylindrical portion ranging from zero to twice the diameter of said cylinder blank;
- The radius r of said internal cavity decreasing from where d = 0 to $d = d_{maximum}$ where the radius r ranges from 35% of the diameter of said cylinder blank to r = 0;
- The maximum value of d ranges from 0.50 to 2.5 times the diameter of said cylinder blank;

c) Formation of the external deformations of the form of grooves, preferably by pressure applied with the appropriate tool or die.

d) Shaping of the end of the ogival nose portion;

e) Calibration of the caliber diameter, made by forcing the projectile through a cylindrical cavity tool;

f) Annealing to the suitable hardness, if necessary;

g) Application of a superficial finish such as polishing (preferably by trammeling), plating with a suitable material, covering (preferably by spraying or dipping in a suitable polymeric material), etc.

Those skilled in the art will realize that the operations encompassed on steps c) to g) can be performed using

methods belonging to the current state of the art, and that the description of one or more of the preferential incorporations of the present invention does not limit its scope of application, which is in fact limited only by the set as defined in claims attached herein.